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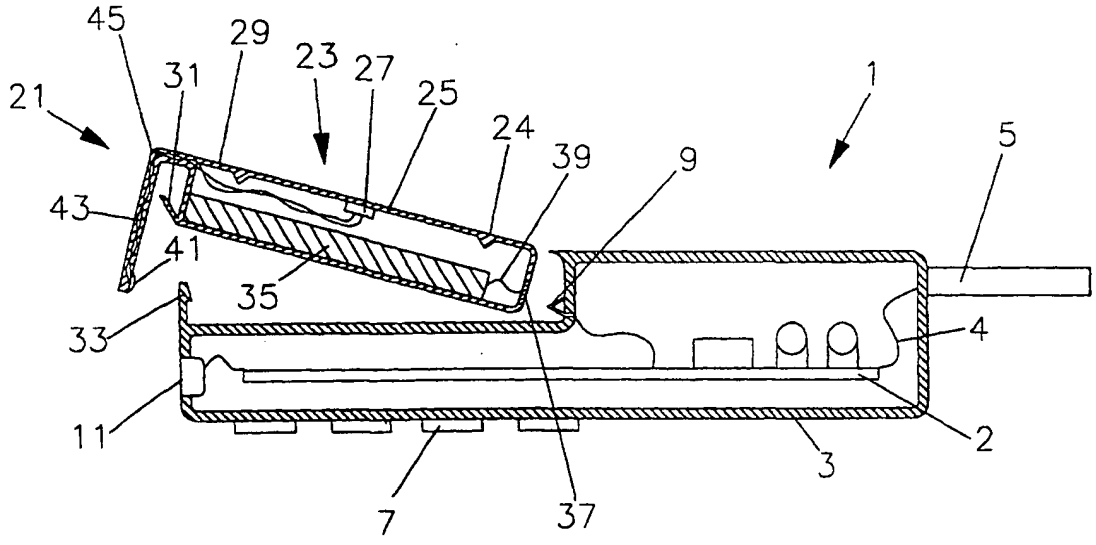
(54) Title: ELECTRONIC EQUIPMENT WITH LOUDSPEAKER



(57) Abstract: A battery pack (21) comprises a battery (35) and a panel loudspeaker (23) integral with the battery pack. The panel loudspeaker may be integral with the casing (29) of the battery pack. The battery pack may be removably inserted in the battery compartment (10) of a piece of electronic equipment for example mobile telephones, personal data assistants, portable computers, laptops, palmtops and the like, indeed any application where battery packs are used.

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TITLE: ELECTRONIC EQUIPMENT WITH LOUDSPEAKER

DESCRIPTION

TECHNICAL FIELD

This invention relates to electronic equipment having a loudspeaker.

BACKGROUND ART

Recently, a new form of loudspeaker has been developed by New Transducers Ltd, as described in several patent applications, for example WO97/09842. Such loudspeakers use resonant bending wave modes excited by a transducer to produce output sound. The loudspeakers are particularly suitable for use with portable electronic equipment, since they can be made both flat and light.

However, many pieces of electronic equipment are already on the market and it would be desirable to allow loudspeakers, especially flat panel loudspeakers, to be retrofitted to them. Although it may be possible to plug

loudspeakers into an existing output port, this requires separate loudspeakers that need to be separately carried and transported. Plugging additional speakers into the electronic equipment is particularly unsuitable for portable and mobile equipment.

It would normally be very difficult to fit loudspeakers integrally with existing equipment, since it would be necessary to remove a portion of the casing of the existing equipment, connect a loudspeaker to the circuitry, and fix the loudspeaker to the casing.

Even in newly designed equipment, there is a need to allow loudspeakers to be more easily fitted to the equipment whilst taking up as little space as possible.

There is thus a need for an approach that allows loudspeakers to be fitted more easily to electronic equipment.

DISCLOSURE OF INVENTION

According to the invention there is provided a battery pack comprising a battery and a loudspeaker integral with the battery pack.

The loudspeaker may be a bending wave speaker comprising an acoustic radiator capable of supporting bending waves and a transducer mounted on the acoustic radiator to excite bending waves in the acoustic radiator to produce an acoustic output. It is preferred to use as

the loudspeaker a resonant bending wave mode loudspeaker having an acoustic radiator and a transducer fixed to the acoustic radiator for exciting resonant bending wave modes. Such a loudspeaker is described in WO98/09842 and other patent applications and publications and may be referred to as a distributed mode loudspeaker.

The properties of the acoustic radiator may be chosen to distribute the resonant bending wave modes substantially evenly in frequency. In other words, the properties or parameters, e.g. size, thickness, shape, material etc., of the acoustic radiator may be chosen to smooth peaks in the frequency response caused by "bunching" or clustering of the modes. The resultant distribution of resonant bending wave modes may thus be such that there are substantially minimal clusterings and disparities of spacing.

In particular, the properties of the acoustic radiator may be chosen to distribute the lower frequency resonant bending wave modes substantially evenly in frequency. The distribution of resonant bending wave modes is less dense at lower frequency than at higher frequency and thus the distribution of the lower frequency resonant bending wave modes is particularly important. The lower frequency resonant bending wave modes are preferably the ten to twenty lowest frequency

resonant bending wave modes of the acoustic radiator. For an acoustic radiator for use in a battery pack, the lower frequency resonant bending wave modes may all be below 2 to 3 kHz.

The resonant bending wave modes associated with each conceptual axis of the acoustic radiator may be arranged to be interleaved in frequency. Each conceptual axis has an associated lowest fundamental frequency (conceptual frequency) and higher modes at spaced frequencies. By interleaving the modes associated with each axis, the substantially even distribution may be achieved. There may be two conceptual axes and the axes may be symmetry axes. For example, for a rectangular acoustic radiator, the axes may be a short and a long axis parallel to a short and a long side of the acoustic radiator respectively. For an elliptical acoustic radiator, the axes may correspond to the major and minor axis of the ellipse. The axes may be orthogonal.

The transducer location may be chosen to couple substantially evenly to the resonant bending wave modes. In particular, the transducer location may be chosen to couple substantially evenly to lower frequency resonant bending wave modes. In other words, the transducer may be mounted at a location spaced away from nodes (or dead spots) of as many lower frequency resonant modes as

possible. Thus the transducer may be at a location where the number of vibrationally active resonance anti-nodes is relatively high and conversely the number of resonance nodes is relatively low. Any such location may be used, but the most convenient locations are the near-central locations between 38% to 62% along each of the length and width axes of the panel, but off-central. Specific locations found suitable are at 3/7,4/9 or 5/13 of the distance along the axes; a different ratio for the length axis and the width axis is preferred.

The acoustic radiator may have selected values of certain physical parameters which enable the acoustic radiator to sustain and propagate input vibrational energy in a predetermined frequency range by a plurality of resonant bending wave modes in a least one operative area extending transversely of thickness such that the frequencies of the resonant bending wave modes along at least two conceptual axes of the operative area are interleaved and spread so that there are substantially minimal clusterings and disparities of spacings of said frequencies, the acoustic radiator when resonating have at least one site at which the number of vibrationally active resonance anti-nodes is relatively high and a transducer mounted wholly and exclusively on the acoustic radiator at one of said sites on the acoustic radiator,

the transducer being capable of vibrating the acoustic radiator in the predetermined frequency range to couple to and excite the resonant bending wave modes in the acoustic radiator and cause the acoustic radiator to resonate and produce an acoustic output.

The acoustic radiator may be in the form of a panel. The panel may be flat and may be lightweight. The material of the acoustic radiator may be anisotropic or isotropic.

The battery pack may have a casing and the loudspeaker may be integrally formed with the casing. Alternatively, the loudspeaker may be formed as a separate component and then attached to the casing so that the loudspeaker is integral therewith.

Since the loudspeaker is integral with the battery pack, it is not necessary for a user to carry separate loudspeakers and a battery pack. Further, by integrating the loudspeaker in the battery pack it becomes possible to retrofit a loudspeaker in existing electronic equipment not having a loudspeaker simply by replacing a conventional battery pack with a battery pack according to the invention.

The battery pack may be for use with electronic equipment which may be a piece of mobile communications equipment, for example a mobile telephone or personal

data assistant. Alternatively, the electronic equipment may be a computer, for example a laptop or a palmtop.

The electronic equipment may have a body defining a battery pack connection terminal, the battery pack comprising a battery output terminal for connection to the battery pack connection terminal. The electronic equipment may further comprise a signal output terminal, and the battery pack may further comprise a signal input terminal for connection to the signal output terminal of the electronic equipment, the signal input terminal being connected to the loudspeaker.

The battery casing may have a lip carrying the signal input terminal for positioning it in contact with the signal output terminal when the battery pack is mounted in the equipment.

When used in a piece of portable electronic equipment, the battery pack loudspeaker permits the equipment to produce sound that is audible at a distance from the phone. Thus, it may no longer be necessary to hold the equipment to use it.

The battery pack can turn a mobile telephone into a portable speaker telephone, which may, for example, be placed on a table to allow the recipient of a call to use his hands, for example to operate a computer, to type, or even, subject to safety considerations, to drive a car.

Moreover, the use of the loudspeaker battery pack can allow the mobile telephone to be located further away from the head of the user, as is now preferred by many users to avoid the microwaves emitted by the radio antenna.

The use of a loudspeaker, particularly a resonant bending wave mode loudspeaker, allows the loudspeaker to be integrated in a battery pack without adding too much to the size and weight of the battery pack. In contrast, a conventional pistonic loudspeaker is likely to add too much to the size and weight of the battery pack to be practical in portable applications. A piezoelectric transducer mounted at a non-preferred location of the casing might produce a satisfactory buzzing sound but without using distributed mode technology such an arrangement is unlikely to produce clear speech or music.

The invention also envisages a piece of electronic equipment comprising a body and a removable battery pack, the battery pack comprising a battery, a casing and a loudspeaker integrated in the casing.

The body may comprise a battery pack connection terminal, and the battery pack may comprise a battery output terminal connected to the battery and removably connected to the battery pack connection terminal. The body may further comprise a signal output terminal, and the battery pack may further comprise a signal input

terminal connected to the signal output terminal of the electronic equipment, the signal input terminal being connected to the flat panel loudspeaker.

The battery pack casing may have a lip carrying the signal input terminal so that the signal input terminal makes physical and electrical contact with the signal output terminal on the body.

Detent means may be provided to hold the battery pack in position on the body with the signal input terminal of the battery pack connected to the signal output terminal of the body and the battery output terminal of the battery pack connected to the battery pack connection terminal of the body.

BRIEF DESCRIPTION OF DRAWINGS

For a better understanding of the invention a specific example will now be described, purely by way of example, with reference to the accompanying drawings, in which:

Figure 1 shows a section through a battery pack and mobile telephone according to a first embodiment of the invention, and

Figure 2 shows a perspective view of a second embodiment of a battery pack and mobile telephone according to the invention.

BEST MODES FOR CARRYING OUT THE INVENTION

Figure 1 shows a mobile telephone 1 having a body 3 containing the necessary electronic circuitry 2 connected via wires 4 to an antenna 5 and a keypad 7. The mobile telephone also has a battery pack connection terminal 9 in the form of a resilient metal contact extending into a battery compartment 10. Further, a signal output terminal 11 is also provided. In the past, this terminal has been used, for example, to provide signals to a hands-free set comprising a headset with microphones. All these features are conventional.

The battery pack 21 has a casing 29 shaped to fit in the battery compartment 10. Integral within the casing is a resilient member 31 which is arranged to co-operate with a latch 33 on the body 3 to act as a detent mechanism to releasably attach the battery pack 21 in the battery compartment 10 of the body 3.

The battery pack contains a battery 35 connected to a battery output terminal 37 via connections 39. The battery may be a lithium ion battery, a NiCd battery, a NiMH battery or any convenient type of battery. The battery output terminal 37 normally functions to supply power from the battery to the electronic circuitry 2 via the battery pack connection terminal 9 of the mobile telephone but the connection can also be used in reverse to charge up the battery when required.

Integrated in the casing is a distributed resonant mode loudspeaker 23 having a panel 25 defined by ribs 24 integral with the casing 29. The panel 25 has its properties, for example its geometric shape, chosen so that the resonant bending wave modes in a predetermined frequency range are as evenly distributed in frequency as is practicable. This may be done by arranging the modes associated with the length of the battery pack to be interleaved with those associated with the width of the battery pack.

A transducer 27 is mounted on the panel 25, close to but not at its centre, to excite it to produce an acoustic output. The transducer is mounted at a location on the panel to couple substantially evenly to resonant bending wave modes in the panel. Such a loudspeaker 23 is described in WO98/09842 and other patent applications and publications and may be referred to as a distributed mode loudspeaker.

The transducer is electrically connected to the signal input terminal 41 by connections 43. The signal input terminal is on a lip 45 of the casing so that the signal input terminal 41 is positioned to engage the sound output contacts of the signal output terminal 11 when the battery pack 21 is mounted in position in the battery compartment 10. Thus, when the battery pack is

mounted, sound output by the mobile telephone on its output sockets may be emitted by the loudspeaker.

A switch may be provided on the battery pack to switch the loudspeaker on and off.

The panel 25 may comprise the whole rear surface of the casing 29 or alternatively the sound emitting panel 25 may be delimited from the rest of the casing 29 by grooves or ribs integral with the casing. An additional member may be provided to clamp the edge or otherwise define the panel 25 in the casing 29.

A signal output terminal 11 may be provided on the inside of the battery compartment 10. In this way, the battery pack 21 can be produced without a lip, saving further space, as shown in Figure 2.

INDUSTRIAL APPLICABILITY

The invention is not applicable only to mobile telephones but may also be applied to personal data assistants, portable computers, laptops, palmtops and the like, indeed any application where battery packs are used.

CLAIMS

1. A battery pack (21) comprising a battery (35) and a loudspeaker (23) integral with the battery pack (21).

2. A battery pack (21) according to claim 1, wherein the loudspeaker (23) is a bending wave speaker comprising an acoustic radiator (25) capable of supporting bending waves and a transducer (27) mounted on the acoustic radiator (25) to excite bending waves in the acoustic radiator (25) to produce an acoustic output.

3. A battery pack (21) according to claim 1 or claim 2, wherein the loudspeaker (23) is a resonant bending wave mode loudspeaker having an acoustic radiator (25) and a transducer (27) fixed to the acoustic radiator for exciting the resonant bending wave modes.

4. A battery pack (21) according to claim 3, wherein the properties of the acoustic radiator (25) are chosen to distribute the resonant bending wave modes substantially evenly in frequency.

5. A battery pack (21) according to claim 3 or claim 4, wherein the resonant bending wave modes associated with a first conceptual axis of the acoustic radiator (25) are arranged to be interleaved in frequency with the resonant bending wave modes associated with a second conceptual axis.

6. A battery pack (21) according to any one of claims 3 to 5, wherein the transducer location couples substantially evenly to the resonant bending wave modes.

7. A battery pack (21) according to any one of claims 2 to 6, wherein the acoustic radiator (25) is in the form of a panel.

8. A battery pack (21) according to claim 7, wherein the panel is flat.

9. A battery pack according to any one of the preceding claims, wherein the battery pack (21) has a casing (29) and the loudspeaker (23) is integrally formed with the casing.

10. A battery pack according to any one of claims 1 to 8, wherein the battery pack (21) has a casing (29) and the loudspeaker (23) is formed as a separate component and then attached to the casing (29) so that the loudspeaker (23) is integral therewith.

11. A battery pack according to any one of the preceding claims, wherein the battery pack (21) is for use with electronic equipment (1) comprising a signal output terminal (11), and the battery pack (21) further comprises a lip (45) for carrying a signal input terminal (41) connected to the loudspeaker (23) and for positioning the signal input terminal (41) in contact with the signal output terminal (11) when the battery

pack (21) is mounted in the electronic equipment (1).

12. A battery pack according to any one of the preceding claims, wherein the battery pack (21) is for use with electronic equipment (1) and the electronic equipment (1) is a piece of mobile communications equipment.

13. A battery pack according to any one of the preceding claims, wherein the battery pack (21) is for use with electronic equipment and the electronic equipment is a computer.

14. A piece of electronic equipment comprising a body (3) and a battery pack (21) according to any preceding claim, the battery pack (21) being removably mounted in the electronic equipment.

15. A piece of electronic equipment according to claim 14, wherein detent means (33) are provided to hold the battery pack (21) in position on the body (3).

Fig.1

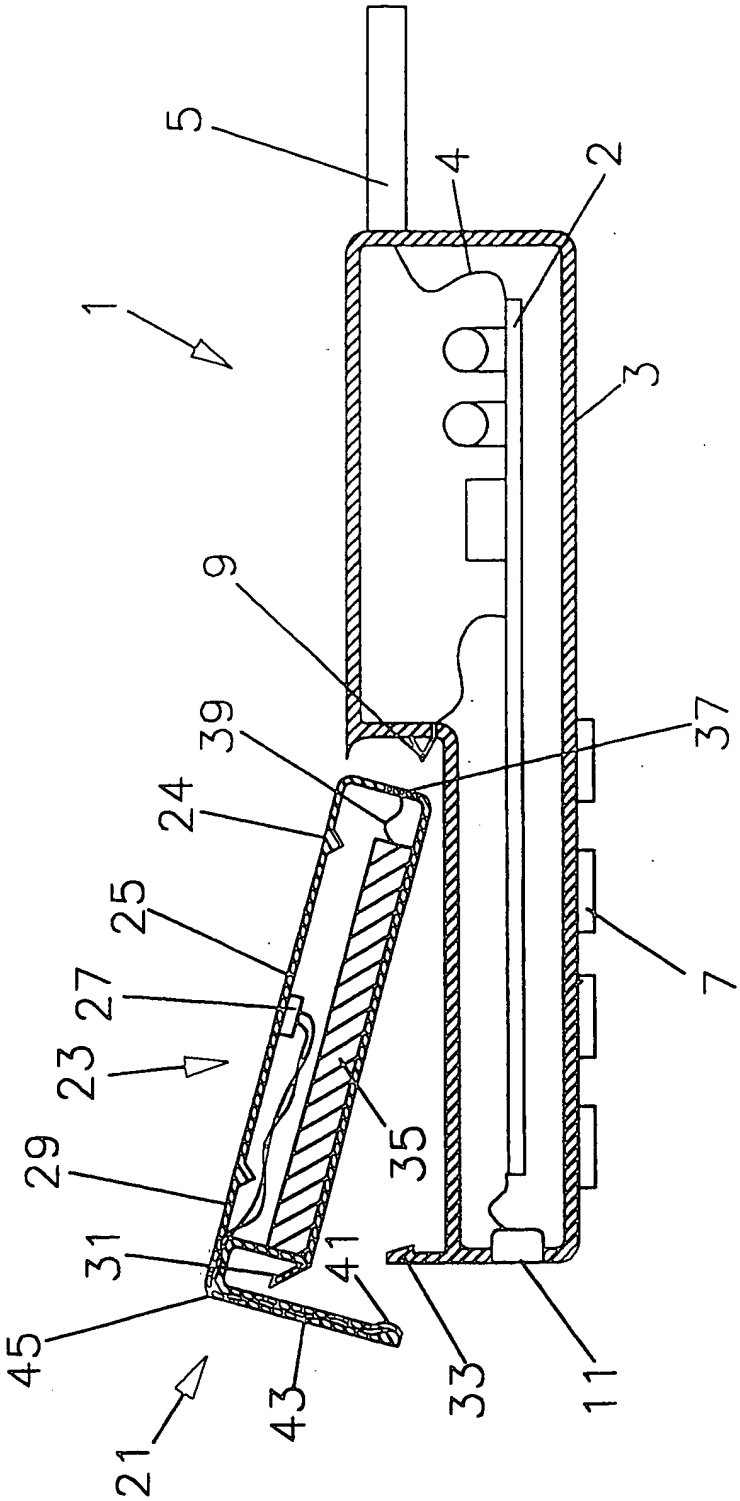
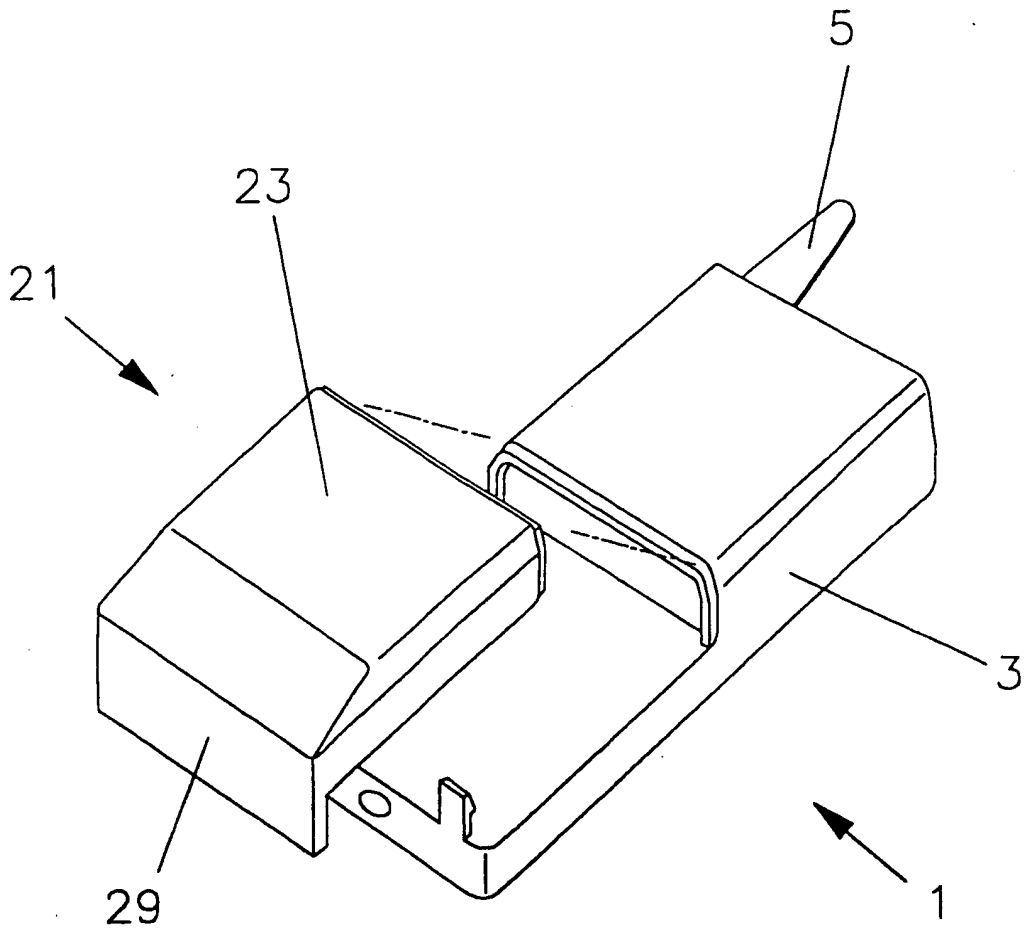


Fig. 2



INTERNATIONAL SEARCH REPORT

Interr nal Application No
PCT/GB 00/03991

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 H01M2/10 H04M1/02

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 H02J H01M G06F H04M

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 0 445 808 A (SONY CORP) 11 September 1991 (1991-09-11) column 9 -column 10, paragraph 4 ---	1,10,12, 14,15
X	GB 2 292 287 A (HUNG CHIN KUO) 14 February 1996 (1996-02-14) claim 2; figure 2 ---	1,10,12, 14
A	WO 98 22987 A (MCTAGGART STEPHEN I) 28 May 1998 (1998-05-28) page 1, line 23 - line 31 -----	1-15

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
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INTERNATIONAL SEARCH REPORT

Information on patent family members

Inter. nal Application No
PCT/GB 00/03991

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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